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IS 12037 (1987): Macrographic examination by sulphur print
(Baumann method) [MTD 22: Metallography and Heat Treatment]



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Indian Standard

SPECIFICATION FOR
MACROGRAPHIC EXAMINATION OF STEEL BY
SULPHUR PRINT (BAUMANN METHOD)

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Indian Standard

SPECIFICATION FOR MACROGRAPHIC EXAMINATION OF STEEL BY SULPHUR PRINT (BAUMANN METHOD)

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Indian Standard

SPECIFICATION FOR MACROGRAPHIC EXAMINATION OF STEEL BY SULPHUR PRINT (BAUMANN METHOD)

0. FOREWORD

0.1 This Indian Standard was adopted by the Bureau of Indian Standards on 21 April 1987, after the draft finalized by the Metallography and Heat Treatment Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 The sulphur print test is essentially a qualitative test. It is inadvisable to assess the sulphur content of a given steel merely on the basis of its sulphur print.

0.3 Experience shows that the degree of darkening of the photo-sensitive emulsion is not always in proportion to the quantity of sulphides present in the metal. Certain factors may influence the macrographic attack to a greater or lesser extent: for examples, the following may be quoted:

- a) Chemical composition of the Steel. The presence of certain elements modifies the type and shape of the sulphide and consequently the appearance of the image obtained, for example, concentrations of titanium greater than 0.1 percent give prints which do not reveal sulphides.
- b) Surface condition of the sample — The presence of surface cold working may alter the image obtained.
- c) The sensitivity of the photographic paper.

0.4 In the preparation of this standard, assistance has been derived from ISO 4968-1979 Steel-Macrographic examination by sulphur print (Baumann method), issued by International Organization for Standardization.

1. SCOPE

1.1 This standard specifies a method (Baumann) for the macrographic examination of steel by means of contact printing using silver salts and sulphuric acid.

1.2 The method is applicable to non-alloy and alloy steel of which the sulphur content is less than 0.1 percent.

NOTE 1 — This method may also be applied to cast irons.

NOTE 2 — In the case of sulphur steels (sulphur content > 0.1 percent), testing may be carried out but with a very dilute solution of sulphuric acid.

2. PRINCIPLE OF THE TEST

2.1 The aim of macrographic examination by sulphur printing is to detect, by printing on photo-sensitive paper* previously soaked in sulphuric acid solution, the position of areas containing sulphur inclusions found in the metal in various chemical forms and with various shapes: iron sulphide, manganese sulphides, mixed sulphides, oxy-sulphides, etc.

2.2 The distribution of the sulphur-rich areas is revealed by the local release of hydrogen sulphide, causing darkening of the sensitive emulsion due to the chemical conversion of the silver halides to silver sulphide.

2.3 By examining the distribution and size of the sulphur inclusions detected by this process, it is possible to make some assessment of the degree of uniformity of the metal from the section examined. Thus sulphur printing reveals chemical irregularities (segregations, for example, those of a non-rimming free-cutting steel) and may reveal certain physical irregularities (for example, cracks and porosity). Furthermore, sulphur printing may be used sometimes to distinguish rimming steel from killed steel and may also draw attention to certain areas where tests (for example, mechanical tests) or sampling for analysis may need to be carried out.

3. PRODUCTS AND REAGENT

3.1 Photographic Paper — The sulphur print is made on the sensitive side of a sheet of photographic paper (or of a flat film) cut to suitable size.

*The photographic paper may be replaced by a flat film. The positive and transparent prints obtained from the flat film may be used directly to produce negative proofs.

3.1.1 In general, the paper used in thin matt paper with a thin layer of gelatine, for example, bromide photographic paper. The clear advantage of this type of paper is that there is less tendency to slip, when it is applied.

3.2 Reagents — Sulphuric acid, commercial, dilute solution, having the following volumetric composition*:

H_2SO_4 (ρ 20 ^{1.84} g/ml)	— 3 volumes
H_2O	— 97 volumes

3.3 Fixing Solution — A commercial fixing solution or a 15 to 20 per-cent solution of sodium thiosulphate in water.

4. TEST PIECE

4.1 The test may be made on the product or on a test piece cut from the product. In general, this consists of a section perpendicular to the direction of rolling for products, such as bars, billets and rounds, or of a surface suitably selected by agreement between the parties.

5. SAMPLING

5.1 In the absence of requirements in the product standards, the number and position of the surfaces examined shall be subject to agreement between the parties.

5.2 It is advisable, in particular, to locate the test surfaces away from the cut faces when cutting has been carried out.

- by hot shearing, which deforms the fibres as well as the inclusions and may greatly offset the segregates;
- by flame cutting which, in the case of hard steels, may produce local hardening, shrinkage, cracks or local tempering.

6. MACHINING

6.1 Preparation of the test-piece surface is of prime importance in obtaining a correct sulphur print.

6.2 While rough machining, resulting in relatively coarse surfaces, may be sufficient in certain cases (routine inspection to reveal shrinkage holes, for example), it is generally required that the machining should be carried out as carefully as possible.

6.3 The criteria to be observed when machining are as follows:

- cutting-tool marking should not be pronounced, for example, as the result of incorrect adjustment, excessively deep cuts or heavy

*Other concentrations may be used, if necessary.

feeds on the lathe or the shaping machine; good results are generally obtained with a feed of approximately 0.1 mm;

b) there should be as little cold working of the surface as possible, due, for example:

1) to a type of tool which is not suitable for the metal or which is badly sharpened; and

2) to the use of unsuitable grinding wheels.

6.4 The main types of machining generally used and leading to accurate prints which are more or less identical, are:

a) grinding with or without preliminary machining; and

b) shaping or turning, provided that the lathe is fitted with a speed adjuster.

6.5 A too smooth finish (mirror-type finish) makes it easier for the paper to slip on the test piece. In general, it is recommended that a surface finish with an R_a of at least $3.2 \mu\text{m}$ be obtained after machining.

7. TEST PROCEDURE

7.1 The photographic paper shall be immersed (*see 3.1*) for approximately 5 min in a sufficient volume of the sulphuric acid (*see 3.2*) at ambient temperature.

7.2 After removing excess acid reagent, for example, by draining, the sensitive side of the paper shall be applied, still damp, to the surface to be examined, which should be clean and free from grease. As an alternative to this procedure, if the piece is small, it may be applied to the paper which has been impregnated before hand. It may be ensured that there is firm contact between the piece and the paper without any slipping, throughout the test. If necessary, external pressure may be applied on the test piece for adequate contact.

7.3 To ensure good contact, air bubbles and drops of liquid shall be eliminated between the surface of the test piece and the sheet of paper, for example, by means of a rubber roller.

7.4 The time of application shall be determined (in advance from the available data concerning the metal to be examined, chemical composition, for example) and also by the type of irregularities to be detected. It may vary from a few seconds to a few minutes.

7.5 The print shall be washed in running water for approximately 10 min, after lightly rubbing it with a wad of wet cotton-wool. The print shall be immersed for at least 10 min in the fixing solution (*see 3.3*) and then washed in running water for at least 30 min and dried.

8. TEST REPORT

8.1 The test report shall include the following information,

- a) the steel grade examined,
- b) the cast number,
- c) the position of the surface examined, and
- d) the result of the test.

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